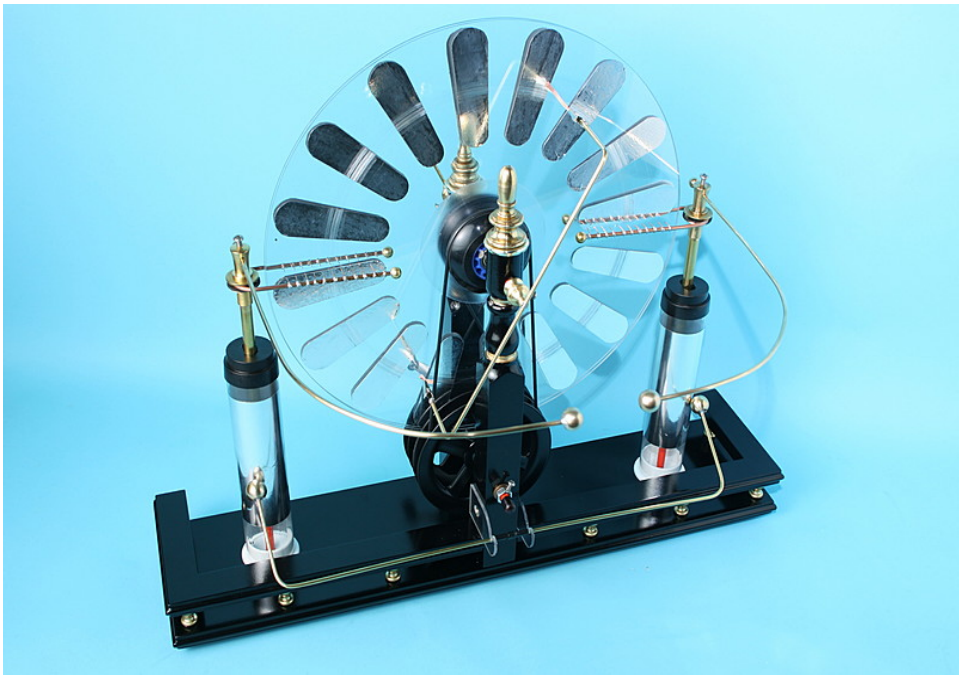

Part 1 – Overview, Materials, and Tools

When assembling a laboratory, the gentleman or lady experimenter should be sure to include a Wimshurst electrostatic generating machine. Not only will this device serve tirelessly for investigations in the field of natural philosophy, interesting parlor games such as the *electric kiss* are also possible! Herein we will demonstrate the construction of such a Wimshurst machine with materials easily acquired from your local home center and hardware store.

Introduction:

Electrostatic machines have always seemed a little like magic to me. I've worked and played with electronics since I was about 6 years old, so I have a thorough understanding of induction and electromagnetism. However, electrostatics are a different thing entirely. These machines that create high voltage charges don't have the familiar coils of copper wire, permanent magnets, and commutators of conventional generators. They are made from brass, glass, and wood, and look more mechanical then electrical. But the coolest thing about electrostatic machines is that you can *feel* them working. As you begin to crank a Wimshurst machine you will hear it start to crackle and hiss with energy, you will smell the sharp scent of ozone produced and you'll feel the hair on your arm stand up as the Leyden jars charge.

Functional Overview:

The main components of a Wimshurst Influence machine are a pair of counter rotating disks with metal strips or *sectors,* a pair of charge collecting *combs*, and a pair of *neutralizing bars* with conductive brushes that contact the sectors. We're all familiar with the static shocks we receive after getting up from our seat and touching a door knob when the weather is dry. That act of separating your posterior from your chair causes a charge imbalance; a Wimshurst machine is essentially an idealized series of posteriors and chairs endlessly


This is another lamp for my bus conversion project, I think it will go Continue Reading →

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sitting and standing with a pair of collecting comb to gather the charge produced so that something useful may be done with it.

Our machine will be built from materials readily available at your local home center and hardware store and can be assembled using common hand tools. The most complicated operations will include some soldering but you will soon discover that attaching brass balls and rods in this manner is much easier then soldering integrated circuits or working with surface mount devices. However, it will require a somewhat larger iron and perhaps a small torch.

History:

Some of the earliest examples of electrostatic generators were build in the seventeenth century and generally consisted of a rotating armature made of amber, sulfur, or glass and a cloth or brush to create friction and induce a charge. These machines had highly variable levels of performance and were quite finicky. They were very dependent on the weather and low levels of moisture in the air and would often fail to function at all on a humid day.

Around 1860 the German physicists Wilhelm Holtz and August Toepler independently developed "influence" machines that created an electrostatic charge without the necessity of having a piece of cloth or fur in direct contact with the rotating armature. These machines did, however, require an initial source from a friction device to provide the charge imbalance that would then be amplified by the rotating machine.

In 1880 James Wimshurst, an English engineer and inventor, became interested in influence machines and started building examples of the most common machines of the time in his home workshop. To these machines he added his own modifications and improvements, refining the design of the metal sectors used by some and developing a machine with two counter rotating disks rather than the single rotating disk previously used. While he never applied for patents on his work, his refinements so improved the function of these influence machines that they became popularly known by his name.

Wimshurst machines were used by scientists and experimenters investigating electrostatics but also, and more significantly, by the medical profession. Wimshurst machines with multiple sets of disks were employed to excite X-ray tubes used in early medical imaging. Smaller Wimshurst machines were also employed to apply electric shocks directly to the patient. While it is unlikely that these shock treatments actually helped the patients of the day, once you get a chance to play with your own Wimshurst machine you will surely understand how a patient might believe that the machine must be doing *something*!

Wimshurst machines also had a place in Victorian entertainment. After a fine meal, guests would often adjourn to the parlor for games, discussion, and demonstrations of a scientific sort. One can imagine that the visceral aspect of the Wimshurst machine with its spinning glass disks, crackle of electrical discharge, and the loud report of the six-inch sparks generated must have made it particularly popular. And for the most adventurous, in the right sort of company, there was a demonstration known as the *electric kiss*.

When demonstrating the properties of electrostatics with the electric kiss, the two volunteers would stand on insulating surfaces. Each would touch one of the two charge collectors of the Wimshurst machine and then they would slowly and without any other part of their bodies touching, bring their lips together for the inevitable "tingle" of electricity.

Please note: it is recommend to demonstrate the electric kiss only with the Leyden jars taken out of circuit since leaving them in will result in quite a painful jolt. I expect the Victorian era contained its share of folks of both sadistic and masochistic bent who took delight in leaving the jars engaged!

Materials:

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Figure 2 wimshurst-materials-blue-bg.jpg

In developing this particular project, I was careful to source material only from my local home center and hardware stores. The one item I was not able to find locally was the pair of large O-rings that I used for the drive belts. Sources for these are provided at the end of this bill of materials. In addition, you may not be able to find the exact hardware that I've used but there are many similar components and you should have little difficulty in finding alternatives.

1. Fluorescent Lamp Protector Sleeve – used to make the two Leyden jars.
2. Staircase Balusters – these will be the supports for the rotating disks.
3. 1/8" Bronze Brazing Rod – will be used to fabricate all of the conductors. If you can't find this at your local hardware store look for a welding supply shop, they are sold by the pound and are incredibly useful for many things even if you don't own an oxyacetylene torch.
4. Fiberglass Driveway Marker Rod – Make sure it's round and 5/16" in diameter; these will be the shafts and insulated supports.
5. 3/8" OD Thin Wall Brass Tubing – one 3' section.
6. Knick-Knack Shelf Kit – approximately 24" by 6". You can use any ¾" board you desire, the shelf included has a nice rail that will add to the overall look of the project.
7. Inline Skate Replacement Wheels – Quantity 2.
8. Lamp Parts – You will need a selection of lamp parts which may vary depending on what is available at your particular store. Pictured here are pull chains, finials, and ball nuts used to make parts of the charge collector combs and discharge electrodes. Also pictured are cabinet knobs which were not used in this project but would make good alternatives. See the charge collector construction step for details.
9. 1" Copper Pipe Hangers – These you'll find in the plumbing section, they are copper plated steel.
10. Solder wick (not pictured) – for the neutralizing brushes, you might have to visit Radio Shack for this.
11. Rubber feet – Quantity 6.
12. Clothes Line Pulleys – must be plastic.

13. 3/16" Acrylic Glazing – enough to cut (2) 14" circles from. Polycarbonate will work too and is easier to work with but costs more than twice as much.

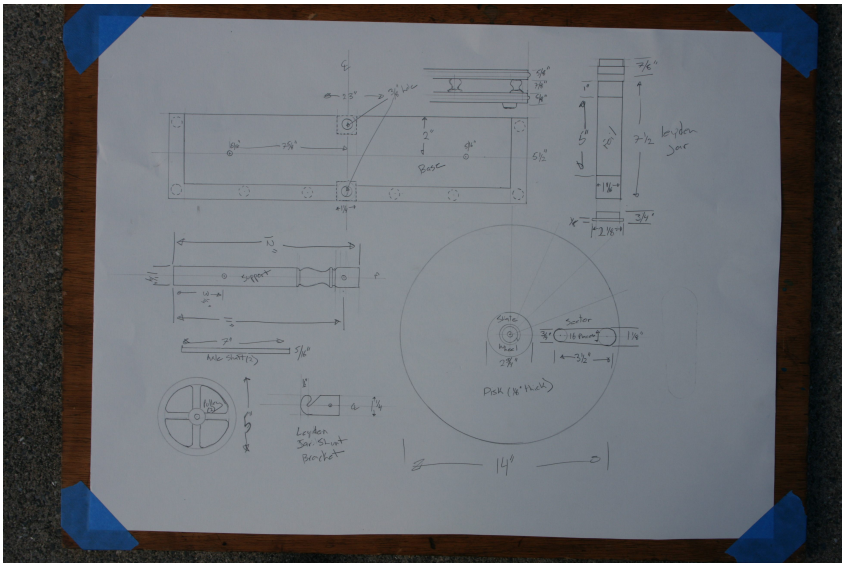
14. Aluminum tape (not pictured) – found with the duct tape and HVAC supplies, get the kind with the peel off paper backing.

15. Rubber O-ring belts (not pictured) – available from McMaster-Carr, part number: 94115K259 about $15 for a package of eight.

The total cost of purchasing the materials new is about $100. However, these are all relatively common items so a little scrounging and perhaps some dumpster diving should net you significant savings.

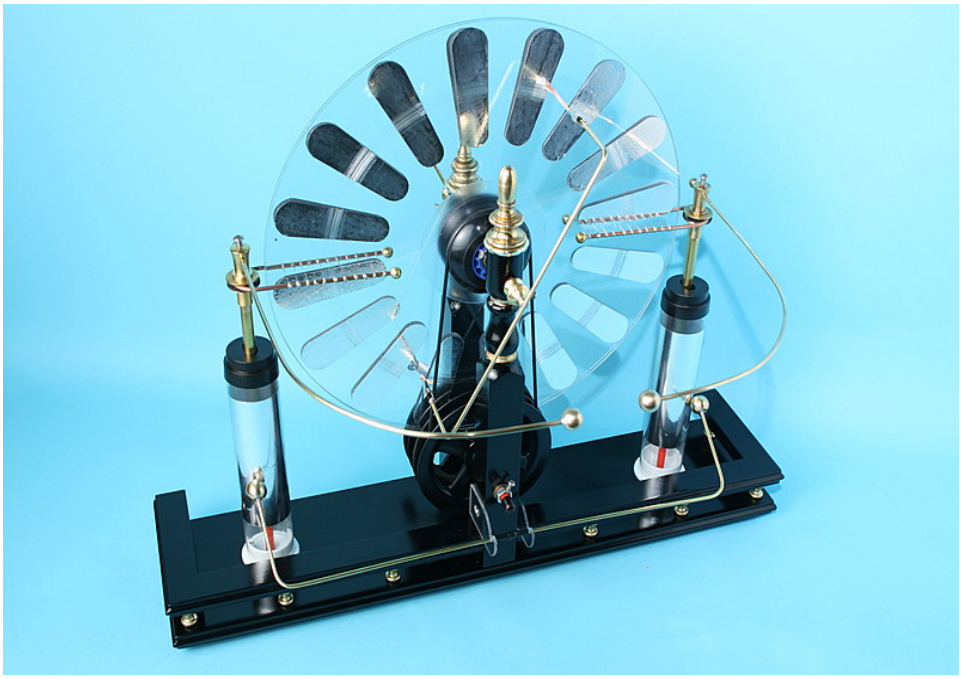
Tools:

- Hack saw with fine tooth blade, coping saw, miter box
- X-acto knife, scissors
- Metal file, 400 grit sandpaper, #00 steel wool
- Power drill, various drill bits inluding 5/16", a counter sink, and multi-step bit
- #6-32 screw tap & handle
- Small soldering torch and/or large solder iron
- Miscellaneous screwdrivers and small pliers
- Tape measure, ruler
- Epoxy, cellophane tape, rosin core solder



(Full size image)

How to Build a Wimshurst Influence Machine – Part 2



Part 2 – Making the disks and preparing the drive components.

This is a moderately difficult project. There is no single operation that is particularly difficult but there are a wide variety of techniques involved. You will likely find the soldering tasks to be the most challenging, but don't fear, it's easier than it looks, and if you practice soldering with some scraps before each operation, you'll do a wonderful job.

Disks and Drive Components:

wimshurst-circle-cutter-inset.jpg

Make the cutting tool:

1. To cut the two 14″ acrylic circles we will first need to make a tool. Cut a 12″ length of wood ¾” square. Pine will work but hardwood is preferable.
2. Drill a pilot hole near one end and press or drive a #6 penny nail through the stick so the point sticks out about ¼”.
3. Drill a second hole exactly 7″ from the first and insert another #6 penny nail into it.
4. Use a fine metalworking file to shape the point of the second nail as shown. You want to make a chisel point with a slight undercut on the leading face.

Cut the acrylic disks:

1. Lay out your circles with a compass to be sure

Jake's Wimshurst Machine and How to Build It! (Part 1)
Last year I wrote an article for Make Magazine volume #17 that described the construction Continue Reading →

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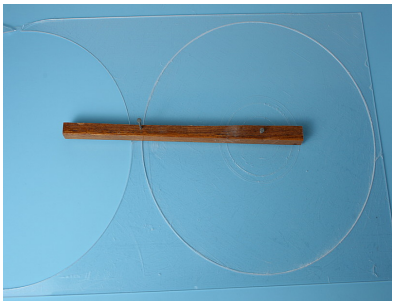
they will both fit on your sheet of acrylic.

2. Drill a 1/8″ hole in the center of your circle. Be gentle when drilling acrylic, it cracks easily. Polycarbonate is quite a bit tougher.
3. Working on a carpeted floor, insert the unmodified nail in the center and begin scoring your circle. Cut about a quarter of the way with each stroke and work your way around the circumference.



wimshurst-circle-cutter.jpg

4. If the cutter sticks, lift it out and move to a different spot.
5. When you think you've gone about halfway through, flip the acrylic sheet over and cut from the other side. You may end up flipping the sheet several times before the circle pops free.
6. Clean up the edge of the circle with some 400 grit sand paper and set them aside.

wimshurst-skate-wheel-groove.jpg

Cut belt grooves in the skate wheels:

1. Gently clamp or strap your drill to a workbench as pictured.
2. Assemble a mandrel from a 5/16″ bolt and some large (fender) washers, when assembled the entire wheel must spin, not just the bearings.
3. Chuck the assembly into the drill. The wheel should turn toward you and the speed should be fairly fast.
4. With a crosscut bastard file make a ¼" wide flat on the wheel and then switch to a rat-tail file to cut the grove. Apply light and even pressure to the file.

Attach the skate wheels to the disks:

wimshurst-skate-wheel-mount.jpg

1. Use a step drill bit like the one pictured to increase the size of the hole in the acrylic disk to 5/16″. Remember, be gentle and go slowly because acrylic is easily cracked.
2. Remove the washers from the wheel and use the 5/16″ bolt to center the wheel against the disk.
3. Drill (4) 1/8″ holes through the disk, don't drill into the wheel.
4. Switch to a 3/32″ bit and drill partway into the wheel in 4 places.
5. Finish the holes with a counter sink.

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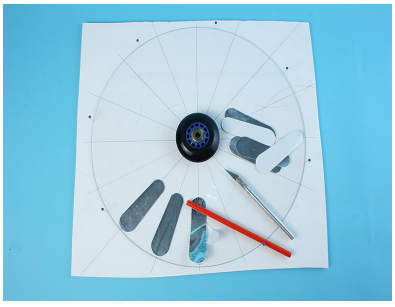
6. Now remove the 5/16″ bolt and drill the center hole out to ½” or 5/8″ using a step drill, you want the edges of the hole completely clear of the rotating parts of the wheel bearing.
7. Install (4) small counter sunken screws, tighten these so they *just* touch the disk, the disk must remain as flat as possible.

wimshurst-sector-cutting.jpg

Cut the sectors:

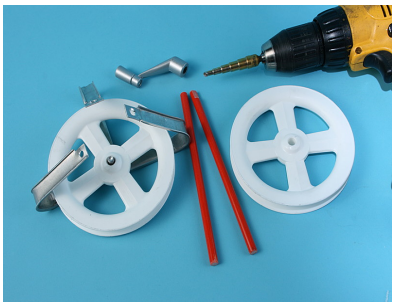
1. Decide how many sectors you are willing to cut. I’m rather lazy and opted for fewer sectors, 16 per disk. If you decide to make 24 or even 32 sectors you’ll have to make them smaller but you will be rewarded with longer sparks.
2. The sectors are cut from aluminum tape. Make a template from a piece of plastic milk jug and trace each sector. Cut them individually, don’t be tempted to stack multiple layers of tape; the cut will end up ragged and will bleed charge away into the air.
3. Tip: I found it easiest to use an X-acto knife and straight edge to cut the long sides and then switch to scissors for the curved ends.



wimshurst-affix-sectors.jpg

Attach the sectors:

1. Lay out a circle on a piece of foam board.
2. Draw radial lines to correspond with the number of sectors you’ve chosen
3. Place your template centered at 6 o’clock and trace it. The large end should face out and be about ¼” from the edge of the disk.
4. Set the disk on the foam board and insert push pins around the circumference so it turns in place.
5. Carefully peel and stick the sector in place. It’s a good idea to make some extra sectors and practice this operation first. A length of fiberglass rod makes an excellent burnishing tool.
6. Turn the disk one line to the left and repeat. Always index the line to the first sector you stuck down, this will help make the spacing as even as possible.

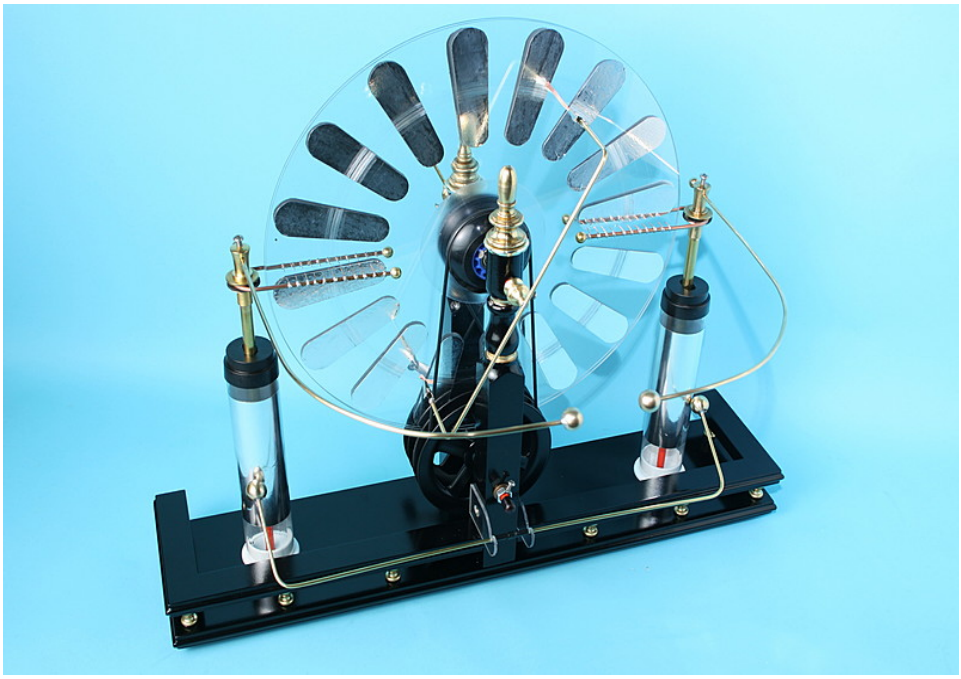


wimshurst-drill-pulley.jpg

Prepare the drive pulleys:

1. Remove the pulleys from their cages by drilling out the rivets.
2. Use the step drill to enlarge the holes to 5/16″. Drill from one side, then the other to enlarge the full depth of the hole in the pulley. Note: The use of the step drill is especially important here because of its self-centering characteristics.
3. Cut (2) 7″ lengths of fiberglass rod, slightly bevel the ends with a file to prevent chip out. Be careful of the glass fibers, they can be really irritating!
4. Drill the splines out of the window crack bore with a regular 5/16″ drill bit. Clamp the crank in a vise and go slowly; making sure the bit is in line with the axis.

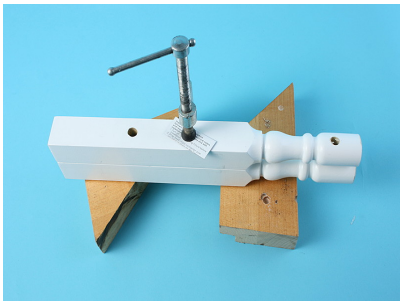
How to Build a Wimshurst Influence Machine – Part 3



Part 3 – Base, Supports, and Fabricating the Charge Collectors and neutralizing bars

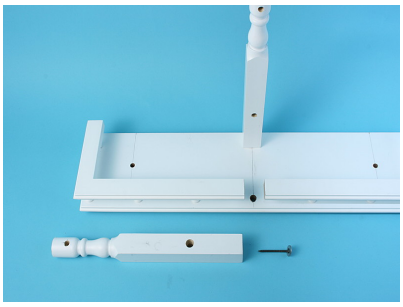
Base and Supports:

Cut and drill the supports:



wimshurst-drill-upright.jpg

1. Cut 12" off of each of the staircase balusters. Choose the end that you think looks best. On my prototype machine I used both ends of the same baluster and thus had two different style supports.
2. Clamp the two supports together as shown and drill 5/16" holes 3 ¼" inches from the bottom (square end) and 11" inches from the bottom.
3. The lower hole will need to be reamed out so that the fiberglass axle turns freely in it. Use a slightly larger drill or rat-tail file for that. You can also drill it larger and insert plastic bushings for smoother operation. Alternatively you can bore it out with a step drill to match the diameter of a pair of skate bearings – this works exceptionally smoothly and is what I ultimately did to my own machine.



wimshurst-screw-uprights.jpg

Attach the supports to the base:

1. Draw a line parallel to the back of the base 2 ½" in, this is not quite to the center. Draw a second line perpendicular to the first on the center of the base.
2. Cut a 1 ¼" gap in the rail on the center line, as pictured.
3. Drill (2) 3/8" inch holes through the base on the center line 5/8" from the front and back edges.
4. Use 2" drywall screws and large washers to attach the supports to the base. The combination of the large washer and 3/8" hole will allow you to adjust and align the position of the rotating disk precisely.
5. Drill (2) 5/16" holes on the line parallel to the long dimension and 7 5/8" from the centerline on each side – these holes need to be straight up and down so drill carefully, use a small carpenter's square to line up the drill.

Charge Combs and Neutralizing Bars:

Prepare the charge collectors:

1. Use a hacksaw to cut off the nail ends of the pipe hanger. The overall length should be 5".
2. You'll find small brass ball cap nuts in the electrical section at the hardware store; they are most commonly used to secure the top of brass outdoor lighting fixtures.

wimshurst-solder-balls.jpg

DIY Engine Driven Welder Part 4 – It Is Alive!

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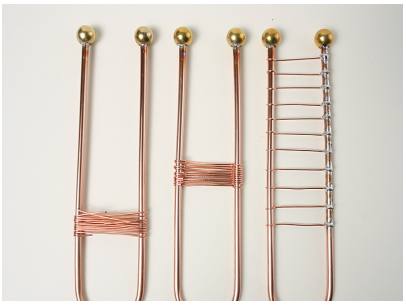
3. Place the small brass ball nuts on the ends of the hanger, heat them with a small torch and apply just enough solder to fill the joint. Note: Be careful not to overheat the pipe hanger, it is copper plated steel and it you heat it too much the solder may not adhere.

The torch pictured is a Lenk LSP-180 butane torch/soldering iron and it is a marvelous tool.

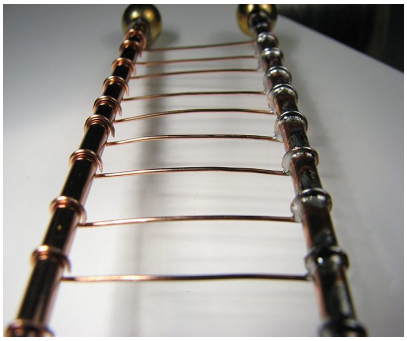


wimshurst-prongs-progression2.jpg

Attach the collector comb prongs:

1. You need to make 8–12 pointy prongs down each side of the collector comb. I stripped the conductors out of a 3' section of telephone wire to make them.
2. Wrap the copper wire around the pipe hanger as shown in the left-most example. I made 11 turns.
3. Cut away the center portion of the wire on one side only and bend the cut ends around the pipe hangers.
4. Spread the prongs out evenly along the portion of the charge collector that will be opposite the sector.

Solder the prongs:

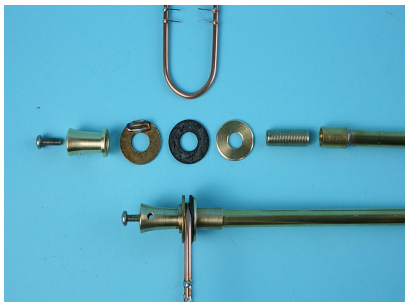


wimshurst-solder-prongs.jpg

1. Crimp the ends tightly around the pipe hanger.
2. Use a large soldering iron to solder each joint. Apply sufficient solder so that when you take the soldering iron away solder flows down to fill the gap at the end of each length of wire. We want to avoid any points other then the prongs themselves.
3. Once you've soldered all of the joints cut down the center of the wires but don't trim them to length until it's time to install the combs.

Charge collector mount:

I made a couple of different collector mounts using various lamp parts and cabinet knobs. This was the simplest, but you may have to improvise if you can't find these particular lamp parts at your local hardware store.



wimshurst-collector-assembly.jpg

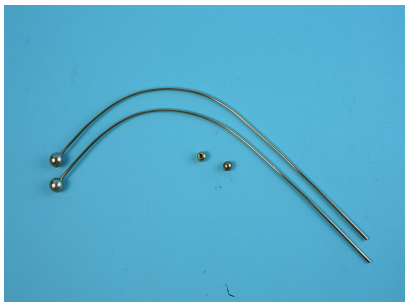
Pictured here right to left:

- 3/8" OD thin wall brass tubing 6" long
- 3/8" threaded collar
- 3/8" lamp "nipple" 1" long
- Lamp washer nut (threaded)
- Rubber flat washer
- 3/8" brass washer
- 3/8" threaded lamp finial
- #8-32 screw

Prepare the collector mount:

1. Using the step drill, bore out one half of the threaded collar.
2. Screw the nipple halfway into the collar and insert the brass tubing into the opposite end and solder it in place.
3. Drill one hole straight down into the top of the finial and thread with a #6-32 tap. Use the drill size written on the tap.
4. Drill a 1/8" hole through the body of the finial as pictured, this is for the discharge electrode.
5. Cut a ½" length from the extra you trimmed off of the pipe hanger earlier and solder it to the brass washer, this will allow the assembly to clamp and hold the charge collector perpendicular to the support.
6. Test assemble the mount and then disassemble

and set aside.



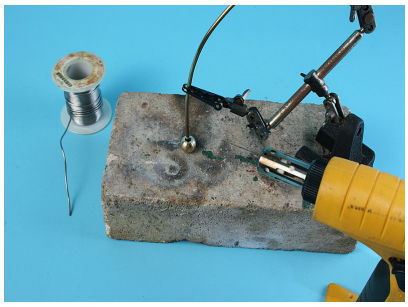
wimshurst-discharge-assembly.jpg

Prepare the discharge electrodes:

1. Cut two 15" lengths of brazing rod and bend them as shown. I bent mine by hand but you could bend a 30" length around a five gallon pail and then cut it in the center for a neater appearance.

wimshurst-discharge-ball-cut.jpg

2. The balls for the discharge electrodes come from some more lamp finials, cut them off just below the ball with a hacksaw. These balls are about ½" in diameter.



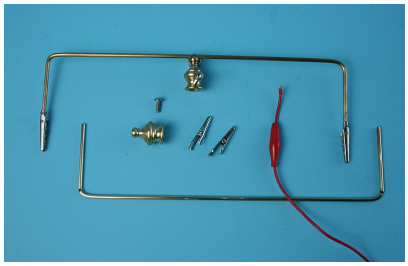
wimshurst-discharge-ball-solder-prep.jpg

3. Solder the discharge balls to the electrodes; fill the hole with solder so it makes a smooth transition to the rod.

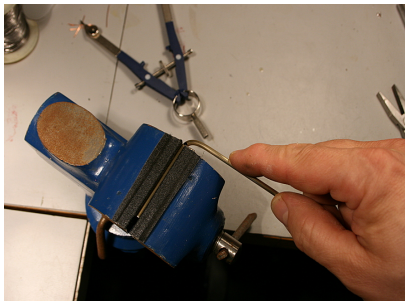
Note: do not solder the small ball nuts in place!

Fabricate the neutralizing brushes:

The neutralizing brushes are made with more brazing rod, alligator clips salvaged from a pair of clip-leads, and yet another type of lamp finial.



wimshurst-neutralizer-bar-parts.jpg



wimshurst-neutralizer-bend.jpg

Bend the brush support:

1. Cut a length of brazing rod 14" long and mark it 2" from either end.
2. Make (2) 90 degree bends in the rod at the 2" marks.

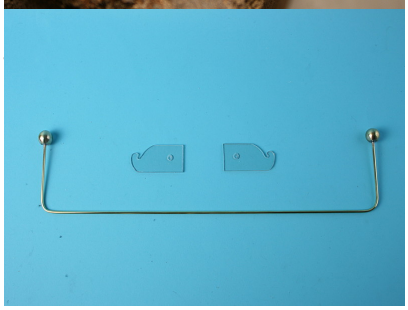
wimshurst-neutralizer-hub.jpg

Solder the brush support to the brush boss:

1. Drill a hole for a set screw in the base of the finial and tap with the #6-32 tap.
2. File a groove in the top of the lamp finials, these particular finals have a 3/8" threaded hole in the bottom and a small hole in the top. I think they are made for ceiling fixtures that have a center pull string.
3. Center the neutralizer bar on the finial and prop it so its parallel to the workbench top and solder it in place.

Attach the brush clips to the support:

1. Crimp the alligator clips on to the ends of the neutralizer bar and solder.



Fabricate the Leyden jar shunt:

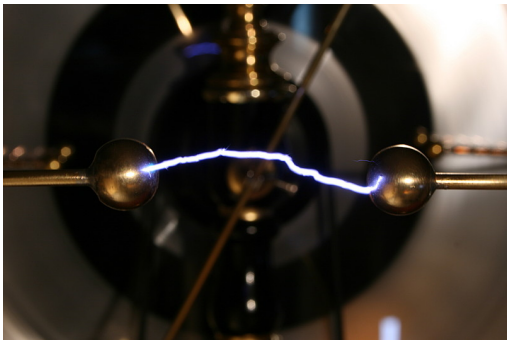
wimshurst-layden-shunt.jpg

1. Cut a 22" length of brazing rod.
2. Make 90-degree bends, 3 ½" in from each end.
3. Solder two brass balls to the end. These are the large brass lamp chain pull balls, smaller finial balls or cabinet knobs would work here, too. If you use knobs be sure to remove any lacquer finish.

How to Build a Wimshurst Influence Machine – Part 4

How to Build a Wimshurst Influence Machine – Part 4

Author: Jake Von Slatt | Posted In Projects | 1 Comment



This is part four in a series of articles describing how to build a Wimshurst Influence Machine with parts and materials available at your local home center and hardware store. In this part I detail the construction Leyden jars and the final assembly. If you missed the beginning of the series start here. This article was originally published in Make: Magazine volume #17.

Building the Leyden Jars and Final Assembly:

Incorporated into Wimshurst's machine are a pair of Leyden Jars which store the electric charge produced and provide for much bigger and more spectacular discharges. Leyden jars were initially invented in 1745 by Ewald Georg von Kleist. However, Pieter van Musschenbroek in Leiden independently developed the same

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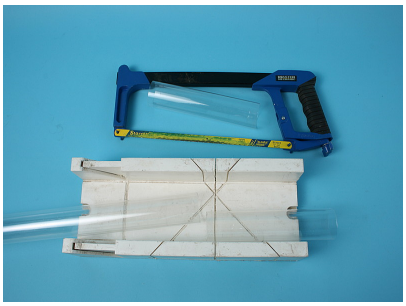
device about a year later and went on to present his discovery to the scientific community. Thus this storage device is commonly known today as the Leyden Jar rather then the Kleist Bottle, though that term is still used occasionally in Germany.

The Leyden jar is the granddaddy of the modern day capacitor. It consists of inner and outer layers of aluminum foil separated by a dielectric or insulator. The amount of charge that a Leyden Jar can hold is determined by the area of these two plates, their distance from each other, and the dielectric or insulating capability of the material used to separate them. The original Leyden jars were made with silver or lead foil and glass. However, plastic is far a superior insulator due to glass' propensity to absorb some water molecules thus reducing is dielectric properties.

Our Leyden Jars are large enough to give you quite a jolt, but not so large as to be capable of actually harming a healthy person. However, Leyden Jars capable of administering a lethal shock are quite easily built – so be sure you fully understand their properties if you decide to construct larger jars. In fact, the first generally acknowledged accidental death by electrocution occurred in St. Petersburg in 1783 when a Professor Richman brought his head a bit too close to a charged bank of Leyden Jars, killing him instantly.

Making the Leyden Jars:

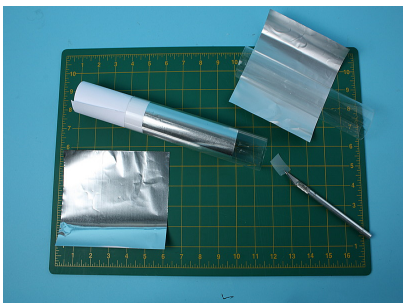
Cut the Leyden jar body:



wimshurst-layden-cut-tube.jpg

1. Using the miter box and fine tooth hacksaw, cut two 7 1/2" lengths from the fluorescent lamp protector sleeve.

Cut and affix the inner plate:



wimshurst-layden-plate-inner.jpg

1. Cut (4) 5" by 6" sheets of heavy duty aluminum foil.
2. Form one sheet by wrapping it around the tube and then rolling it so it can be inserted. Roll along the 6" axis so the foil cylinder ends up being 5" high.
3. Insert the foil into the tube so that it is 1" from one end. Use a couple of rolled up sheets of paper to hold the foil firmly against the inside of the tube while you tape it in place. The tighter

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you can make it to the inside of the tube the better.

wimshurst-layden-plate-outer.jpg

Affix the outer plate:

1. Wrap another piece of aluminum foil around the outside and tape it in place. Again, the tighter the better, but don't wrinkle the foil.

wimshurst-layden-plate-bottom.jpg

Make the bases:

1. Snap the tube ends onto the opening that is 1" from the foil
2. Make the Leyden jar bases from a pair of plastic closet pole mounts. Drill out the center hole to 5/16".

Note: These are Stanley brand and I had to trim some reinforcing ribs off with an X-acto knife to make them slide into the tubes.

Final Assembly:

Mount the disks and drive line:

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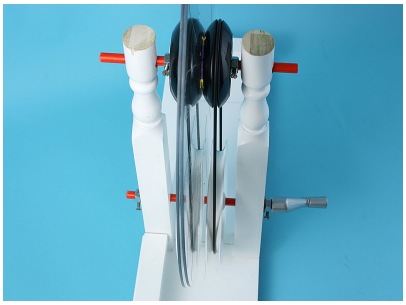
1. Slide the disk axle into a support and put on a 5/16" set screw collar, an O-ring belt, the two disks, the other belt, and another collar.

2. Attach the casement window crank to the drive shaft, insert the bushings in the supports if you are using them and slide the shaft through the pulleys. The pulleys should be a tight fit and you will have to twist the shaft back and forth to get it through. Don't forget about the belts hanging from the top shaft, one will need a twist so that the disks rotate in opposite directions. A collar goes on either end of the drive shaft.

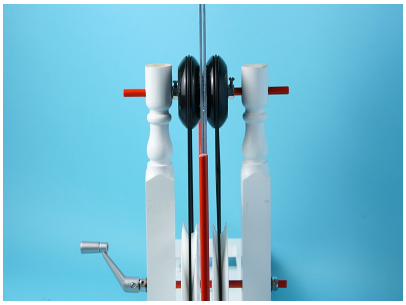
3. Once both shafts are in place, stretch the belt around the pulleys. (In the picture, the belt with the twist is hidden behind the disk. What you are seeing is a reflection of the untwisted belt.)



wimshurst-axle-collars.jpg

Note: 5/16" set screw collars can be found at the hardware store but I made my own by drilling out a 5/16" nut and threading a #6-32 screw into the side.

Note: I found that my machine became difficult to turn once it was fully charged due to the electrostatic attraction of the disks. I cut a 2 ½" washer from a plastic milk jug and placed it on the shaft between the disks to remedy this problem.



wimshurst-lineup-collectors.jpg

Align the disk and collector supports:

1. Cut two 11" lengths of fiberglass rod and press them into the holes made earlier in the base.

2. Loosen the screws that hold the two supports to the base and slide them around to adjust the disks so they line up with the charge collector supports.

3. Re-tighten the supports.

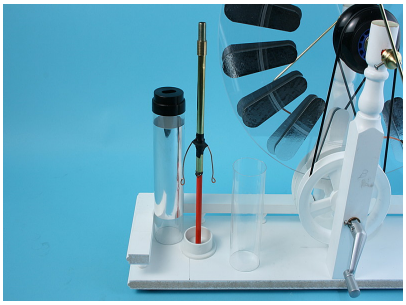
Install the Leyden jar base and inner plate contact:

1. Slide the Leyden jar bases onto the fiberglass charge collector supports.

2. Slide the charge collector assembly over the fiberglass supports.

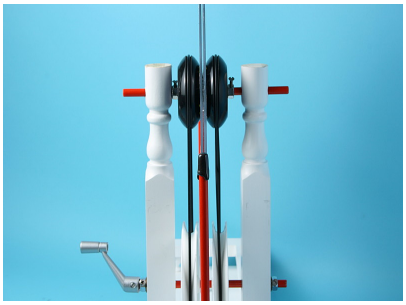
3. Using about 6" of 14 AWG solid copper wire, form the inner plate contact. Wrap it once around the brass tube and form two loops in the ends.

4. Using a scrap of the plastic tube as a guide, adjust the inner plate contacts so they apply even and gentle pressure. You want good contact with the foil but you don't want to rip the foil when you install the Leyden jars.



wimshurst-layden-contact-inner.jpg

Epoxy the charge collector assembly in place:

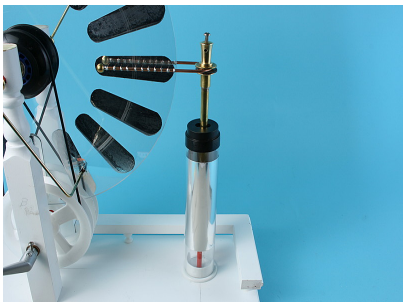


wimshurst-collector-epoxy.jpg

1. Apply epoxy to the end of the rod and slide the brass charge collector assembly down onto the fiber glass support rod.

2. Set aside while the epoxy cures.

Install Leyden jar and assemble collector:



wimshurst-layden-complete.jpg

1. Slide the Leyden jar onto its base, being careful not to tear the foil as makes contact.

2. Line up the charge collector comb and trim the prongs. Test spin the disks to see if there is any wobble and trim the prongs to come as close as possible to the disks without touching.

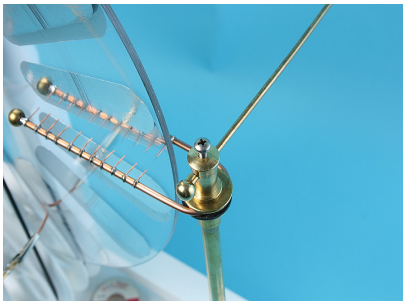
3. Assemble the charge collectors.

Install discharge electrode:

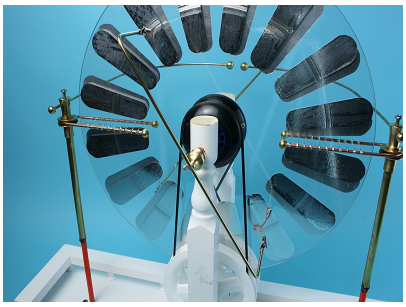
1. Insert the discharge electrodes into the lamp finial on the charge collector and tighten the screw to hold it in place.

2. The finial should be tight enough to hold the collector comb but allow the discharge electrode to move back and forth. If it's too tight, or not tight enough, the support rod can be twisted in the base to accommodate.

3. Wrap a small bit of tape around the end of the electrode and screw on one of the small ball nuts; this will prevent charge from bleeding off the sharp end.



wimshurst-collector-inplace-2.jpg



wimshurst-neutralizer.jpg

Install neutralizing brushes:

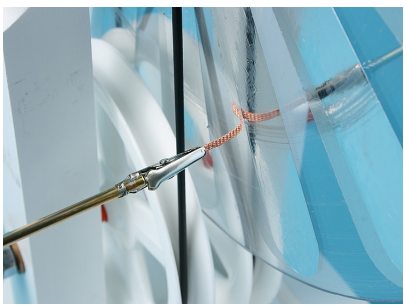
1. Slide the neutralizing bars onto the upper shaft and adjust them to be about 45 degrees from the collector combs.

2. Sectors should pass through a charge collector, encounter a neutralizing bar after about 1/6 of a rotation, and then encounter the other charge collector after a further 1/3 of a rotation.

3. Tighten the set screw to secure.

Position brushes:

1. Clip (2) 1 ½" lengths of Solder Wick™ to the ends of the neutralizing rods so they make good contact with the disk.



wimshurst-neutralizer-brush.jpg

wimshurst-complete-front.jpg

Mount the Leyden jar shunt and add optional finials:

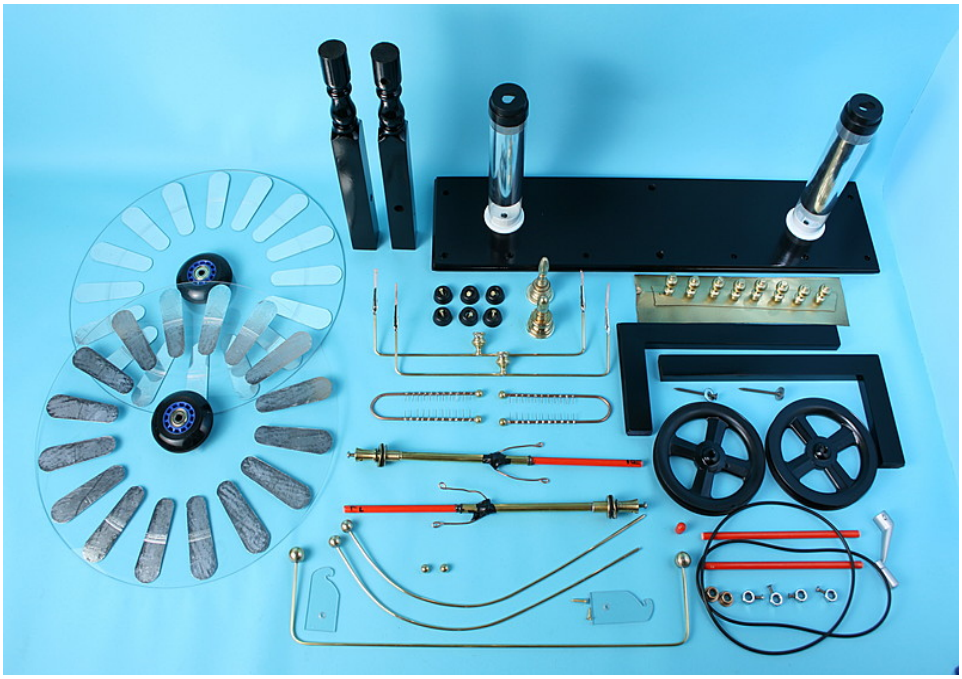
1. Use small brass wood screws to attach the (2) acrylic brackets to the front disk support, leave them a little loose at first.
2. Place the Leyden jar shunt in the brackets and line them up so the balls on the shunt lean comfortable against the Leyden jars.
3. Tighten the brackets.

The two tops of the disk supports looked a little bare to me so I raided my junk box for more lamp parts and came up with these decorative finials. The wealth of finial and cabinet knobs at the typical home center means that there are infinite opportunities for creativity here!

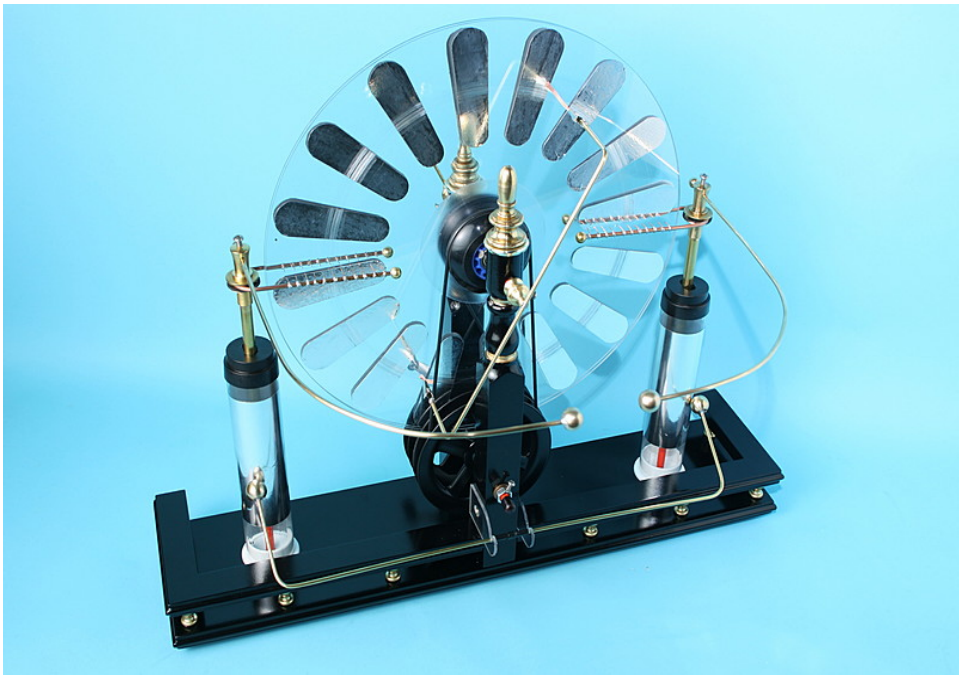
That's it! Your Wimshurst machine is done!

wimshurst-complete-back-2.jpg

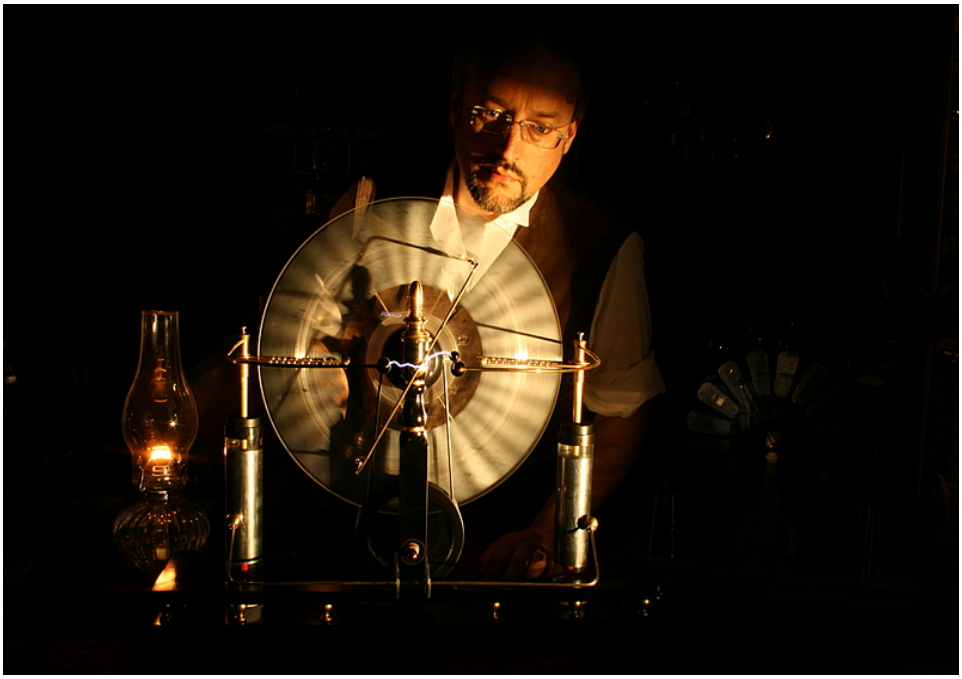
Painting is optional but I decided that my machine would look better in black and gold so I completely disassembled it and painted the base and supports with black lacquer. I also painted the plastic pulleys with Krylon Fusion, but that turned out to be a mistake. If you do paint your pulleys, make sure to mask the area where the belt contacts the bottom of the pulley groove to prevent the belt from peeling off the dried paint.



wimshurst-all-parts-laid-out-painted.jpg



How to Build a Wimshurst Influence Machine – Operation and Adjustment



Operation:

A note of caution first: while this machine is unlikely to produce sufficient charge to injure a healthy individual directly, it can and will produce enough of a jolt to knock you off your feet and who knows what your head might hit on the way down. Respect it!

There are three variables that you can play with to vary performance. The size of the spark gap can be adjusted, the angle of the neutralizing bar can be varied, and the Leyden jars can be switched in and out of circuit with the shunt. Start with the spark gap set to about an inch, the neutralizers at 45 degrees to the collector combs (90 degrees to each other) and the Leyden jars disconnected.

Now start to turn the crank smoothly and at a moderate speed. With this configuration the machine should show a thin blue spark. Look closely at the spark and you'll notice that one end of it is brighter, this it your positive electrode.

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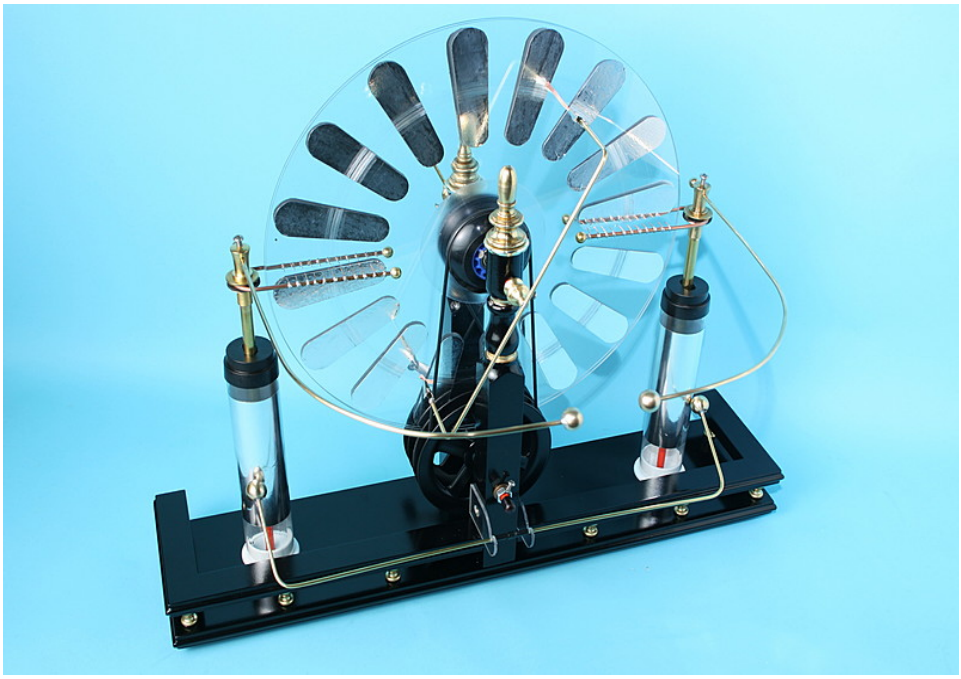

Stop cranking and engage the Leyden jars. Be warned, the Leyden jars can hold a charge for hours or even days. From this point on you should consider the machine "hot" and liable to bite unless you short the electrodes. Also be warned that Leyden jars can acquire charge just sitting there so you need to discharge them each and every time before you touch the electrodes. Turn the crank again, seemingly nothing will happen for several revolutions. Then you'll hear the neutralizing brushes start to crackle, you'll smell the fresh scent of ozone, then finally CRACK! a strong blue spark will jump the gap.

Take a screwdriver and short the electrodes together and then reposition them a little further apart. Crank some more and you'll see a bigger spark. Repeat this procedure and eventually something different will happen. You'll see multiple small sparks jump from one of the collectors, across several sectors, and to a neutralizing brush. When you see this, you've reached the maximum spark length your machine is capable of.

The maximum spark length of your machine is slightly larger then the sum of the sector spaces between the neutralizing brush and the closest collector. Slightly larger because it harder for the spark to jump multiple gaps verses a single gap due to the charge distribution on the sectors. This is why a larger number of smaller sectors will result in a high voltage and thus a longer spark.

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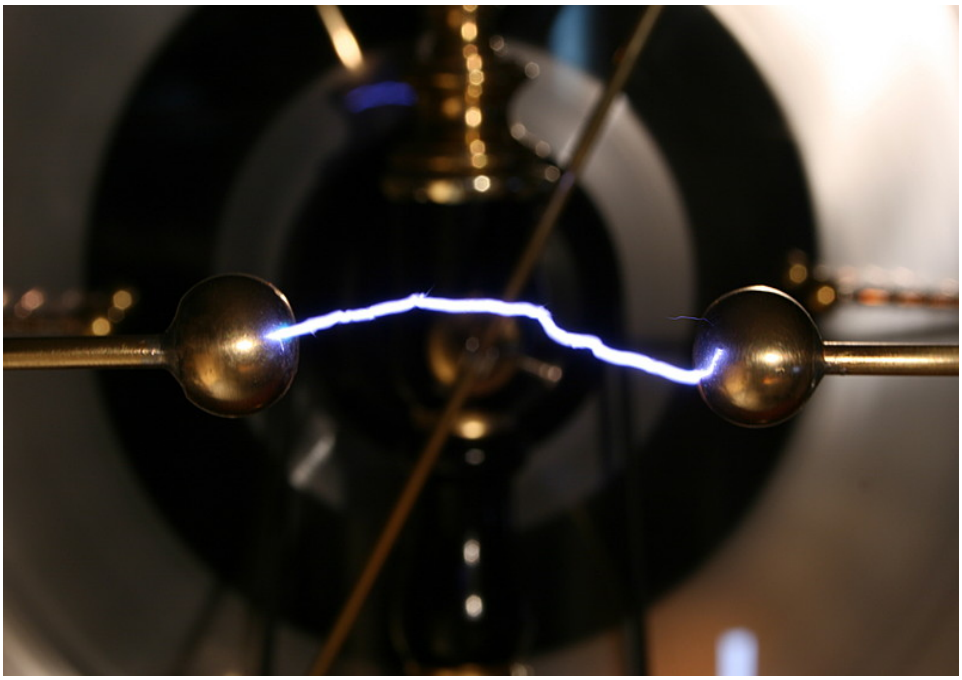
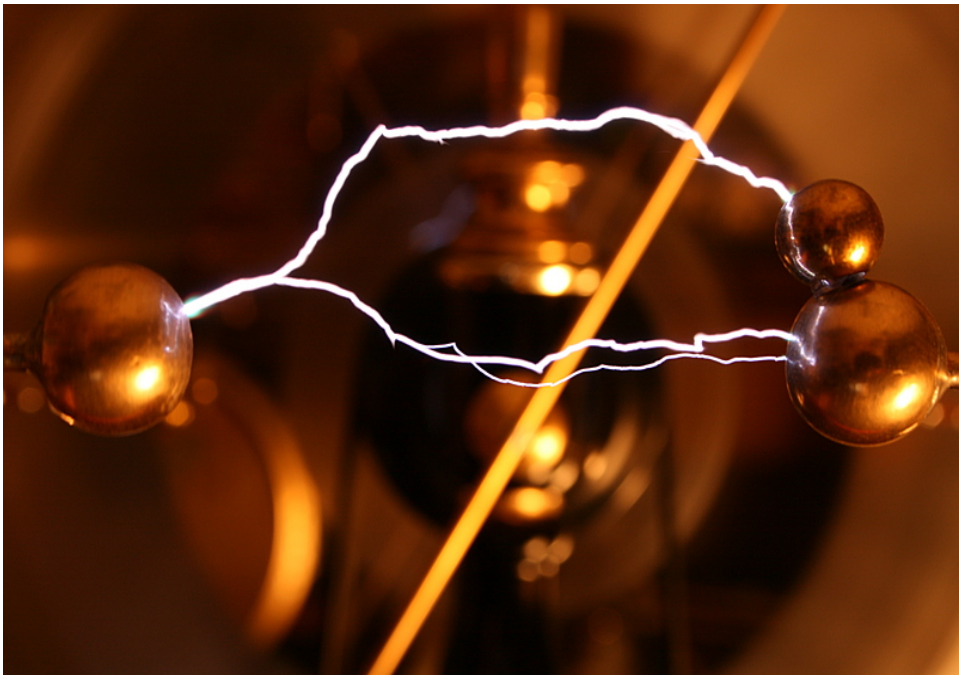
Some small adjustment can be made to the neutralizing bars at this point. Setting the bars at about 60 degrees to each other will increase the maximum voltage at the expense of a small decrease in current.



Finally, there's one trick that can be very helpful if you want to take photographs of your machine in operation or just need two hands free for your experiments. Simply remove the windows crank from the drive axle by loosening the set screw and clamp an adjustable speed drill directly to the 5/16" shaft. Increase and decrease speed slowly to avoid belt slippage. Depending on the balance of your disks you should be able to spin the machine quite quickly. Note that spinning the machine fast does not increase spark length, only decreases the charge time between discharges.



Attaching a small ball to the positive electrode will result in larger and more interesting sparks. The small ball creates a plume of ionized air that helps the spark jump the gap.

Your machine should require little maintenance over time, but may require periodic replacement of the belts and cleaning of the disks. Use only water to clean the disk as contaminates will cause charge to bleed away. If you suspect the there is some oil on the disks, gently wipe them with rubbing alcohol and be sure to remove any film left behind.

I really enjoy playing with this machine I've built; it's a constant source of entertainment! However, I am beginning to experience something that I was warned about by other Wimshurst builders. I want to make bigger and bigger sparks and it occurs to me that I could cut two 48" disks from a single 4 by 8 foot sheet of polycarbonate . . .

For further reading on the subject I would suggest:

Ford, R. A. Homemade Lightning: Creative Experiments in Electricity, McGraw-Hill/TAB Electronics, 2001

Francis, G. W. Electrostatic Experiments: An Encyclopedia of Early Electrostatic Experiments, Demonstrations, Devices, and Apparatus, Electret Scientific Company, 2005